Pathways and Regulation of Aquatic Nuisance Species into British Columbia's Waterways

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Abstract
Aquatic nuisance species are of concern in British Columbia not only because of the extent of the province's marine coastline, but also because of the large network of freshwater lakes and rivers which support commercially important species. There are numerous pathways of introduction of nuisance species into British Columbia's aquatic systems. These include ballast water, the pet and aquarium trade, live seafood and transportation of pleasure boats from the Great Lakes area. There is limited documentation of the status of aquatic nuisance populations in the province. European Green Crab *(Carcinus maenas)*, Zebra Mussels *(Dreissena polymorpha)*, Eurasian Water Milfoil *(Myriophyllum spicatum)*, Purple Loosestrife *(Lythrum salicaria)*, Common Carp *(Cyprinus carpio)* and Spartina *(Spartina alterniflora)* are among the nuisance species that have been observed in British Columbia.

Review of federal and provincial legislation that are applicable to limiting the intentional introduction of aquatic nuisance species shows that many regulatory gaps exist. For example, Schedule VIII, Section 5 of the Pacific Fisheries Regulations of the Canada Fisheries Act provides a list of prohibited live fish for importation. The adequacy of this list for the purpose of preventing the importation of species that might threaten local indigenous species needs to be examined. Present knowledge of aquatic nuisance species and their pathways of introduction provide a basis for updating some of these regulations.

Introduction
British Columbia has extensive marine coastlines and large networks of freshwater lakes and rivers that provide habitat for many commercially important species. The introduction of aquatic nuisance species can disrupt the population dynamics of resident species and devastate the local productivity. Sometimes aquatic nuisance species out-compete existing populations. They become so ubiquitous that they can become commercially important themselves. The varnish clam (*Nuttalia obscurata)* is an example of such a species in British Columbia (Gillespie et al 1999).

The objective of this paper is to describe some of the major aquatic nuisance species of concern or prominence in British Columbia and to summarize the pathways of introduction. Current legislation will be discussed in the context of their applicability to aquatic nuisance species. Finally, an example will be used to describe some of the problems with existing legislation and few non-legislative approaches will be presented.

Aquatic Nuisance Species in British Columbia
At present there is limited documentation of the status of aquatic nuisance species in British Columbia. European Green Crab (*Carcinus maenas*), Zebra Mussels *(Dreissena polymorpha)*, Eurasian Water Milfoil *(Myriophyllum spicatum)*, Purple Loosestrife *(Lythrum salicaria)*, Common Carp *(Cyprinus carpio)* and Spartina *(Spartina alterniflora)* are among the nuisance species that have been observed in British Columbia.

The European Green Crab *(Carcinus maenas)* has received a lot of attention since it was first introduced into the San Francisco estuary in the early 1990s. It is slowly spreading northward up the coast and has been found in BC. Partly through the diligence of the shellfish industry, this species has not taken off in BC as it was first feared it would. There have only been six individual crabs found in Southern BC, all in Vancouver Island waters. Larval transport in surface ocean currents is one of the theories of how this species is spreading on the Pacific Coast.

Eurasian water milfoil (*Myriophyllum spicatum)* was accidentally introduced to the Okanagan Lake system in the early 1970s and rapidly spread to become a problem of shore dwellers, recreational boating, swimming and other aquatic species. It formed dense canopies crowding out native species and is an ongoing problem for residents. Mechanical control is carried out annually. Public education is aimed at boaters who compound the problem by carrying Eurasian water milfoil to other areas on propellers and by creating fragments that can reproduce rapidly to form complete plants.

Purple loosestrife *(Lythrum salicaria)* is an attractive purple plant that was accidentally introduced in the 1800s and has spread to virtually every province and state in North America. Its colourful flowers and hardiness promote planting as an ornamental; however, one adult plant can dispense several thousands of seeds annually. Purple loosestrife has formed dense stands and become a problem for wetland birds and animals. It crowds out native plants, destroys marshes and chokes streams.

In 1999, live Zebra Mussels *(Dreissena polymorpha)* were found on a boat trailered from Michigan to BC for a boat show. The public was notified to be on the lookout for this species through sport fishing guides and distribution of Zebra Mussel identification cards. No other observations have been made since then. (Lim 2001).

Other aquatic nuisance species have no doubt entered BC waterways, but without ongoing monitoring, records are not available. The importance of documenting the presence of these potentially harmful species before they become established cannot be underestimated. Methods of rapid assessment surveys have been developed in San Francisco Bay to provide baseline information of the presence of non-indigenous species. Locally, a survey was done in Puget Sound that confirms the value of this approach to documenting changes to aquatic communities. Thirty-nine non-indigenous species were collected and identified in six days of sampling (Cohen et al 1998). Whatever technique is used, it is paramount to record the appearance of these species in BC waterways.

Pathways

It is important to identify the pathways of introduction of aquatic nuisance species. Without this knowledge, risk assessment and control measures cannot be determined or established. Pathways identified in BC include: aquaculture, ballast water (Piercey et al 2000), pet and aquarium industries, live food trade, research, and transportation of pleasure craft from areas infested with nuisance species such as the Great Lakes.

Legislation

In a review of existing federal and provincial legislation and their effectiveness at limiting the intentional introduction of aquatic nuisance species into BC waterways, many regulatory gaps are found. The legislations that have provisions for regulation of biological introductions are the Canada *Fisheries Act* (General Regulations Sections 55 and 56, Pacific Fisheries Regulation Schedule VIII, Section 5), BC *Wildlife Act*, BC *Fisheries Act*, and *Canadian Environmental Protection Act* (CEPA, New Substances Notification Regulations).

The planting, introduction, and transport of aquaculture products (which includes oysters and Manilla clams) into or within BC is regulated by Section 8/Regulation 364/89 of the BC Fisheries Act. Live freshwater fish possession, transport, and traffics must be authorized by a permit or license under the BC Wildlife Act. These two legislations are limited as they do not specify species and exclude certain fish (goldfish and ornamental tropical fish) from regulation. Therefore they do not prevent the movement, establishment or sales of many aquatic nuisance species.

The Federal-Provincial Introductions and Transfers Committee has representatives from each province. In BC there are four meetings a year to review applications for release of fish into BC waters and use in fish rearing facilities. In 2002 there were 450 applications in BC. Sixty percent of these were repeat applications, generally for routine hatchery movements of eggs and juveniles. Canada *Fisheries Act* has a list of prohibited fish for importation (Table 1). This list was compiled in 1924 and is Schedule VIII (Section 5) of the Pacific Fishery Regulations, which provides a list of fish specifically prohibited from live import into the province of BC.

Table 1. Canada *Fisheries Act,* Pacific Fishery Regulations, 1993.

SCHEDULE VIII

(Section 5)
PROHIBITED IMPORT LIVE FISH

Common Name of Species	Scientific Name of Species
Bass, Blue Gill sunfish	*Acatharchus, Ambloplites, Centrarchus, Enneacanthus, Lepomis, Micropterus, Morone,* *Perca, Percina, Pomoxis,* and *Stizostedium*
Blackfish (Sacramento)	*Orthodon*
Bowfin	*Amia calva*
Buffalo Fish	*Ictiobus*
Carp	*Catla, Cirrhina, Ctenopharyngodon, Cyprinus, Hypothal michthys, Labeo,* and *Mylopharyngodon*
Catfish	*Clarias, Ictalurus, and Noturus*
Drum (Sheepshead)	*Aplodinotus*
Eel	*Anguilla*
Minnow (Fathead)	*Pimephales*
Gars	*Lepisosteus*
Lamprey	*Ichthyomyzan, Lampetra,* and *Petromyzon*
Pike	*Esox*
Quilback and Carpsucker	*Carpiodes*
Roach	*Leuciscus*
Rudd	*Scardinius*
Shad and Alewife	*Alosa* and *Dorosoma*
Stickleback	*Apeltes, Culaea (Eucalia), Gasteroteus steus,* and *Pungitius*
Sucker	*Catostomus, Cycleptus, Erimyzon, Hypenelium, Minytrema,* and *Moxostoma*
Tilapia	*Tilapia*
Moon snail	*Polinices*
Oyster crab	*Pinnotheres*
Oyster drill	*Thais, Ocenebra,* and *Urosalpinx*
Rock lobster	*Jasus*

Test of Regulatory System

Using the Chinese Mitten Crab (*Eriocheir sinensis*) as an example of an aquatic nuisance species that should not be allowed into BC, the inadequacies of the existing regulatory system are evident. The Chinese Mitten Crab invaded California in 1992. It is omnivorous and highly desirable in Asian Food markets and, if introduced to BC waterways, has the potential to destroy fish habitat and cause widespread economic and ecological damage. This species is not on the Prohibited Live Fish Import list, nor is it an aquaculture product and therefore could be imported into Canada. In BC, this has been tested and Chinese Mitten Crab was not allowed to enter the province solely due to public health concerns as they can carry an oriental lung fluke. This example serves to underline that the legislation in existence does not provide adequate safeguard against the transport of aquatic nuisance species into BC.

Non-legislative Solutions

Non-legislative solutions are another approach that can be effective to prevent the introduction of aquatic nuisance species. Best management practices, peer pressure, advertisement and education/outreach are possible examples of these. The cleaning of recreational boats to prevent the movement and spread of Eurasian Water Milfoil and Zebra Mussels

are best management practices presently used. Peer pressure is evident in commercial shipping self-regulation of ballast water management. There are presently no enforceable regulations regarding ballast water discharge, but the general shipping community is recognizing that mid-ocean exchange will minimize the risk of introduction of non-indigenous species and therefore peer pressure is one of the elements that make ships perform that exchange. Advertisement and education/outreach have limitless possibilities to inform the general public about the risks of aquatic nuisance species. By using these solutions, more and more people will recognize not only the risk but the species themselves. Through information campaigns it is possible to identify pathways and presence of species of concern. As legislative change is a slow process, non-legislative solutions should be actively used to prevent the spread of aquatic nuisance species.

Summary

Several aquatic nuisance species are of concern in British Columbia waterways. Many commercial species and habitats need to be protected from the invasive, explosive properties of nuisance species that have been globally identified. Many have appeared in BC and many more are close. Although some pathways have been identified, further work needs to be done to find more so control can be designed and risk assessed. Existing legislation is inadequate to protect from the introduction of aquatic nuisance species and their fate and disposal once established. Non-legislative approaches such as education/outreach and best management practices should be used to further the interest in nuisance species and provide information so more observations can be made by those actively working or playing in the aquatic environment.

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